Financial Deepening-Economic Performance Nexus,

An attempt to Study Granger-Causality through Spectral Time Series Analysis in MENA Countries

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Abstract

In this paper it is considered that the series may have a repetitive or cyclical behavior across time by referring to the Fourier analysis; which is an important part in the modern treatment of Economic Time Series. The goal of this is to test the causality Granger between financial deepening and economic performance in MENA countries using the spectral analysis that is a special case of the Fourier analysis; according to different time horizons (short, medium and long term) without subdividing the study period which extends from 1970 to 2014. For reliable results, the sample was divided into two subsamples, the countries of the Gulf Cooperation Council (GCC), which have a high income, and other countries.

On high frequencies, estimates show that the real and financial sectors maintain causal relationships, showing a limit of the conventional method of causality assessment that sets in many cases a complete lack of connection between the proxies. In the long term, finance dominates in some Gulf Cooperation Council (GCC) countries while we have the opposite effect in other countries.

The main conclusion that one can reach is that the causal relationship between finance and growth is not linear, but it varies depending on the chosen time horizon.

Keywords:

Financial Depth, Economic Performance, Spectral Analysis, Fourier Transform, Granger Causality.

I. Introduction

The studies on the relationship between finance and economic growth often use multivariate linear models such as vector autoregressive models (VAR models) and vector error correction models (VECM models) and operate the entire period. However, it is known that the economic environment in a given country is not the same throughout the study period and the results that can be found may be wrong. Indeed; there are exogenous factors beside the endogenous factors that may influence the finance and economic growth nexus, especially in developing countries. Include, among others, political instability in these countries, their relationship with international bodies (IMF and World Bank), and climatic conditions and so on...

And to study this relationship, it makes more sense to decompose the study period into sub-periods according to the given economic context. In this regard, Granger and Lin, 1995 and Breitung Candelon (2006) reported that links between different phenomena are not linear, but vary depending on the selected frequency bands. The decomposition of the study period into sub-periods has the inconvenience of reducing the number of observations that would question the robustness of the statistical tests based more often on asymptotic properties. Spectral analysis overcomes this disadvantage by measuring causality following different frequencies while keeping all observations of the study period in each of these frequencies.

However, what about the choice of sub-periods? ; Otherwise, how to bring up any form of periodicity in the movements of macroeconomic series?

For a long time classical decomposition of these movements into four components (trend, seasonality, cyclical motion and random movement) has used classical techniques of descriptive statistics. If determining the trend and seasonal movement is relatively simple, that of the cyclic movement is more complicated because it requires the subtraction of the two previous movements. This led to seek more sophisticated methods to highlight the cyclical component representing in some cases the fundamental element that generates the data generating process.

Early research in this area has used the harmonic analysis method. This method consists in adjusting a periodic function to the observed series. But the nature of time series is generally characterized by imperfect periodicity (which is always true for macroeconomic data), which leads to a limit of application of applying this method.

To solve this problem researchers are oriented towards spectral analysis, which is an extension of harmonic analysis that studies the time series in the frequency domain by replacing the time domain. It consists to research solution from trigonometric functions that are composed of several sinusoids and each has its own frequency and therefore its own periodicity. This method has a better fit of the data as it is based on the sum of partial periodic functions. These are two ways of representation and study of stationary data that are not opposite, but complementary. The transition from one representation to another is performed by Fourier transforms through the spectral representation theorem, which states that "any stationary in covariance process can be decomposed into a sum of sinusoidal oscillations whose amplitudes and offsets are independent random variables of a sine wave to the other"

The rest of the article is organized as follows, Section 2 presents the literature review, section 3 focuses on the model and the estimation method, empirical validation shall be presented in Section 4 and Section 5 concludes.

II.   Literature revue

The theory of the business cycle has developed in the last century by the famous work of Juglar, Schumpeter (Schumpeter, 1939, 177), one of the greatest economists of all time. Juglar stresses the need to find the causes of the recession in the phases of prosperity.

The economic cycle is a concept relatively complex and raises multiple and difficult issues.

Detection of economic cycles is usually based on a decomposition of the time series into a trend, and cyclical components. This approach is not sitting on uniform and indisputable theoretical foundations; however, two approaches are imposed. The first approach is based on economic theories or structural models in which the different relationships have generally accepted economic interpretations. On the

contrary the second approach is based on neutral statistical and analytical tools and then seeks to find economic explanations for the various components of economic dynamics.

The present research methodology is purely instrumental and constructivist, it is based on spectral analysis and rather it is in line with the second approach.

The spectral analysis of time series in the economic field dates back to Granger and Morgenstern (1962). The works that followed them were interested in seasonal phenomenon (Nellore (1964) and general spectral structures of economic time series, Granger (1966). The cospectral methods, including coherence and phase are subsequently used to quantify the relationship between economic variables, one among them to evaluate the presence of linear relationship between series and the second to measure their time offset.

Geweke (1984, 1986) proposed a simpler method using tests based on the coefficient of determination. He applied the tests on the causal relationships between the gross domestic product growth (GDP) and the money supply on the one hand, and between the GDP growth rate and the GDP deflator in the US economy over the period 1929-1978, on the other hand.

For example, Gronwald (2009), in a study of causality between oil prices and economic and financial variables, showed that there is a short-term causal relationship between oil prices and the interest rate to short term and the consumer price index; at low frequency (long term), the author has shown a significant causal relationship between oil prices and the long-term interest rates; he found a total lack of causality between the oil price and industrial production on the one hand, and between oil prices and the unemployment rate on the other.

Through the bivariate and multivariate spectral analysis on US macroeconomic data from 1959 to 1997, Hart et al. (2009) suggest a cyclical behavior of the change in gross domestic product, employment and wages for a period of five to seven years. Finally, they found a pro-cyclical movement between the product level and the index of consumer prices, particularly in the period 5-7 years. Similarly, Aguiar-Conraria and Soares (2010) have established an unstable relationship between oil prices and industrial production, according to the frequencies, with a form of alternation in the causality between the two variables. By combining the Wavelet Method to the frequencies analysis, they also show that the inflation

rate and the growth rate of industrial production follow pro-cyclical movements of decrease from 1950 and 1960.

Based on the frequencies approach, Breitung and Candelon (2006) have shown that the spread (difference between the interest rates of long and short term) in the short term is an explanatory factor for the change in US GDP. Furthermore, their study examines the property of finished samples by Monte Carlo simulations. Hosoya (1991) has also developed Frequency causal measures applied to stationary data comparable to those of Geweke (1982); starting with the measurement of the amount of information Gel'fand and Yaglom (1959).

Yao and Hosoya (2000) have extended this approach to "unilateral causal study applied to cointegrated time series. Thus, the Johansen approach to estimating the maximum likelihood cointegration was adopted as the likelihood-ratio test. And that furthermore, their method also provides a confidence intervals construction procedure using Dewald statistical tests (1943). By studying Japanese macroeconomic data; these authors have found:

- A lack of causality between money supply and GDP in the short term,
- Significant influence of interest rates on GDP while the reverse causality is very low,
- A significant contribution of exports to GDP,
- A low incidence of the money supply on exports,
- An important impact of imports and exports on the money supply and interest rates.

In some Granger multivariate causality studies, and for certain frequency band values, Chen et al. have shown that the spectral method can lead to negative statistics that are difficult to be interpreted. They propose a matrix of partition method to overcome this problem.

However, it is important to note that the spectral approach remains more

a descriptive analysis tool than a recognized method for forecasting. It remains also a powerful tool for the cyclical study, and measuring the contribution of one variable to change other variables.

III.   Econometric method

1. The econometric model and Fourier transformation

In the following development, the financial deepening variable is denoted by X, the economic growth variable by Y and we assume an unconstrained model:

$$\begin{cases} a_1 X_{t-1} + a_2 Y_{t-1} = u_t \\ a_3 X_{t-1} + a_4 Y_{t-1} = v_t \end{cases} \Leftrightarrow \begin{cases} a_1(B)X_t + a_2(B)Y_t = u_t \\ a_3(B)X_t + a_4(B)Y_t = v_t \end{cases} \quad (1)$$

- B, is the lag operator;
- $a_1(0) = 1, \quad a_2(0) = a_3(0) = a_4(0) = 0;$
- u_t and v_t are random variables;
- $E(u_t) = E(v_t) = 0$;
- $V(u_t) = \sigma^2{}_{u_t}$, $V(v_t) = \sigma^2{}_{v_t}$ and $Cov(u_t, v_t) = \sigma_{u_t, v_t}$.

To pass from the representation in time to that frequency requires the application of Fourier transforms of the equations. In the case of discrete data, we get the following relationships:

$$\begin{cases} a_1(\alpha)X(\alpha) + a_2(\alpha)Y(\alpha) = E_x(\alpha) \\ a_3(\alpha)X(\alpha) + a_4(\alpha)Y(\alpha) = E_y(\alpha) \end{cases} \Leftrightarrow \begin{pmatrix} a_1(\alpha) & a_2(\alpha) \\ a_3(\alpha) & a_4(\alpha) \end{pmatrix} \times \begin{pmatrix} X(\alpha) \\ Y(\alpha) \end{pmatrix} = \begin{pmatrix} E_x(\alpha) \\ E_y(\alpha) \end{pmatrix} \quad (2)$$

$$\Leftrightarrow A(\alpha) \times M = B$$

The components of the latter matrix are the *Fourier transforms* of the coefficients of the time domain equations. $A(\alpha)$ is called Fourier coefficient matrix.

$$a_1(\alpha) = 1 - \sum_{j=1}^{p} a_{1,j} e^{-i\alpha j}$$

$$a_2(\alpha) = 1 - \sum_{j=1}^{p} a_{2,j} e^{-i\alpha j}$$

$$a_3(\alpha) = 1 - \sum_{j=1}^{p} a_{3,j} e^{-i\alpha j}$$

$$a_4(\alpha) = 1 - \sum_{j=1}^{p} a_{41,j} e^{-i\alpha j}$$

α is the fundamental Fourier frequency. We assume $\alpha \in [0, \pi]$.

$$A(\alpha) \times M = B \Leftrightarrow M = A^{-1}(\alpha) \times B \Leftrightarrow \begin{pmatrix} X(\alpha) \\ Y(\alpha) \end{pmatrix} = \begin{pmatrix} a_1(\alpha) & a_2(\alpha) \\ a_3(\alpha) & a_4(\alpha) \end{pmatrix}^{-1} \times \begin{pmatrix} E_x(\alpha) \\ E_y(\alpha) \end{pmatrix}$$

$$\Leftrightarrow \begin{pmatrix} X(\alpha) \\ Y(\alpha) \end{pmatrix} = \begin{pmatrix} \dfrac{a_4(\alpha)}{\det A} & \dfrac{-a_2(\alpha)}{\det A} \\ \dfrac{-a_3(\alpha)}{\det A} & \dfrac{a_1(\alpha)}{\det A} \end{pmatrix} \times \begin{pmatrix} E_x(\alpha) \\ E_y(\alpha) \end{pmatrix} = \begin{pmatrix} F_{xx}(\alpha) & F_{xy}(\alpha) \\ F_{yx}(\alpha) & F_{yy}(\alpha) \end{pmatrix} \times \begin{pmatrix} E_x(\alpha) \\ E_y(\alpha) \end{pmatrix} \qquad (3)$$

The spectral density denoted d of the Fourier transform can be written:

$$d(\alpha) = \begin{pmatrix} F_{xx}(\alpha) & F_{xy}(\alpha) \\ F_{yx}(\alpha) & F_{yy}(\alpha) \end{pmatrix} \times \begin{pmatrix} \sigma^2_{u_t} & \sigma_{u_t,v_t} \\ \sigma_{v_t,u_t} & \sigma^2_{v_t} \end{pmatrix} \times \begin{pmatrix} F_{xx}(\alpha) & F_{xy}(\alpha) \\ F_{yx}(\alpha) & F_{yy}(\alpha) \end{pmatrix}^{\dagger} = \begin{pmatrix} d_{xx}(\alpha) & d_{xy}(\alpha) \\ d_{yx}(\alpha) & d_{yy(\alpha)} \end{pmatrix} \qquad (4)$$

Note: t means the transposed matrix

The interdependence to the frequency α between X and Y is measured by the following report:

$$R_{X,Y} = Ln \frac{d_{xx}(\alpha) \times d_{yy}(\alpha)}{\left| d_{xx}(\alpha) \times d_{yy}(\alpha) - d_{xy}(\alpha) \times d_{yx}(\alpha) \right|} \qquad (5)$$

Indeed, the spectral density contains the spectra of each variable and the cospectrum of X and Y. The cospectrum shows whether the X and Y variables are dependent or not.

If X and Y are independent, then the determinant of the density $d(\alpha)$ is the product of individual spectra, the cospectrum being null.

When X and Y are independent, R_{xy} can be written:

$$R_{X,Y} = Ln \frac{d_{xx}(\alpha) \times d_{yy}(\alpha)}{\left| d_{xx}(\alpha) \times d_{yy}(\alpha) - d_{xy}(\alpha) \times d_{yx}(\alpha) \right|} = \ln\left(\frac{d_{xx}(\alpha) \times d_{yy}(\alpha)}{d_{xx}(\alpha) \times d_{yy}(\alpha)} - \frac{d_{xx}(\alpha) \times d_{yy}(\alpha)}{d_{xy}(\alpha) \times d_{yx}(\alpha)} \right) \quad (6)$$

2. Granger causality measure

We know that according to Granger(1969):

- The variable Y Granger causes X at time t, if and only if:

$$E\left(X_t / \tilde{X}_{t-1}, \tilde{Y}_{t-1} \right) \neq E\left(X_t / \tilde{X}_{t-1} \right)$$

- The variable Y instantaneously Granger causes X at time t, if and only if:

$$E\left(X_t / \tilde{X}_{t-1}, \tilde{Y}_t \right) \neq E\left(X_t / \tilde{X}_{t-1}, \tilde{Y}_{t-1} \right)$$

Where $\tilde{X} = \{X_t, X_{t-1}...\}$ and $\tilde{Y}_t = \{Y_t, Y_{t-1}...\}$ indicate the past of X and Y.

In the case of spectral analysis, the measurement of the unidirectional causal requires the decomposition of the spectrum of each series, this process is called normalization.

The decomposition of X-spectrum is given by:

$$d_{xx}(\alpha) = F_{xx}(\alpha) \times \sigma_{u_t}^2 \times F_{xx}^\dagger(\alpha) + 2\sigma_{u_t v_t}\left(F_{xx}(\alpha) \times F_{xy}^\dagger(\alpha) \right) + F_{xy}(\alpha) \times \sigma_{v_t}^2 \times F_{xy}^\dagger(\alpha) \quad (7)$$

- The term $F_{xx}(\alpha) \times \sigma_{u_t}^2 \times F_{xx}^\dagger(\alpha)$, represents the intrinsic part of the causal relationship;
- The second term indicates the instantaneous causality,
- and the third term indicates the causal effect of X on Y due to $\sigma_{v_t}^2$.

Finally, the causal effect on x generated only by Y, is obtained by canceling the second term.

To find the causal effect on Y generated by X, we reason from the same way. The decomposition of X- spectrum is given by:

$$d_{yy}(\alpha) = F_{yy}(\alpha)\sigma^2_{v_t}F^{\dagger}_{yy}(\alpha) + 2\sigma_{v_t u_t}\left(F_{yy}(\alpha) \times F^{\dagger}_{yx}(\alpha)\right) + F_{yx}(\alpha)\sigma^2_{u_t}F^{\dagger}_{yx}(\alpha) \qquad (8)$$

IV.   Empirical validation

1. The data

The study period runs from 1970 to 2014. The sample studied contains 20 MENA countries including six GCC countries: Algeria, Bahrain, Djibouti, Egypt Arab Rep. , Iran Islamic Rep. ,Iraq ,Jordan ,Kuwait, Lebanon, Libya ,Malta ,Morocco ,Oman ,Qatar ,Saudi Arabia ,Syrian Arab Republic ,Tunisia, Yemen Rep. ,West Bank and Gaza.

The sample will be divided into two subsamples. i.e. the GCC: Saudi Arabia, the UAE, Bahrain, Oman, Qatar and Kuwait, and other MENA countries. This division is justified by the fact that the GCC countries hold nearly half of global oil reserves, its GDP reached $ 1,619 billion in 2015, have a per capita income quite high compared to other countries that exceed $ 30,000 and they have established a customs union and a common market in 2015.

The variables used to measure financial deepening and economic performance are successively, the natural logarithm of credit to the private sector relative to gross domestic product (lnCREDIT) and the natural logarithm of gross domestic product per capita growth rate (lnGDP). These variables are transformed into first differences in the aim of making stationary.

The data are from the World Development Indicators (WDI) and the IMF international financial statistics database.

2. Results of the Granger causality test

In this causal study:

- We consider annual periods: denoted T
- The zero hypothesis H0 is that there is no unidirectional causality at T period, between the

variables of interest.

- $\alpha = \dfrac{2\pi}{T}$, represented the Fourier fundamental frequency.

Table 1. Granger causality in frequencies in GCC countries

	H0: lnCREDIT does not cause lnGDP				H0: lnGDP does not cause lnCREDIT			
α	π	$\dfrac{\pi}{2}$	$\dfrac{\pi}{4}$	0	π	$\dfrac{\pi}{2}$	$\dfrac{\pi}{4}$	0
T	2	4	8	$+\infty$	2	4	8	$+\infty$
Saudia Arabica	0.102**	0.023*	0.032*	0.214**	0.012	0.124	0.025	0.254***
UAE	0.035*	0.024*	0.136	0.124***	0.127*	0.087	0.031*	0.169
Bahreïn	0.124	0.124*	0.117	0.128*	0.177*	0.192	0.065	0.251
Oman	0.025**	0.083	0.182*	0.231**	0.154	0.136*	0.065	0.325
Qatar	0.142*	0.127	0.171	0.025	0.099*	0.125	0.021	0.231
Kuwait	0.111*	0.033	0.147	0,178*	0.123*	0.054	0.111*	0.135
Notes: asterisks *, * and *** successively meaning the rejection of H0 at the 10%, 5% and 1% significance levels								

Table 2. Granger causality in frequencies in the rest of MENA countries

	H0: lnCREDIT does not cause lnGDP				H0: lnGDP does not cause lnCREDIT			
α	π	$\dfrac{\pi}{2}$	$\dfrac{\pi}{4}$	0	π	$\dfrac{\pi}{2}$	$\dfrac{\pi}{4}$	0
T	2	4	8	$+\infty$	2	4	8	$+\infty$
Algeria	0.032	0.214	0.111	0.233	0.089**	0.122**	0.011	0.288
Djibouti	0.124	0.074*	0.009	0.265	0.127	0.121	0.127*	0.269
Egypt Arab Rep.	0.136	0.129*	0.094	0.199	0.028*	0.222**	0.037	0.197
Iran Islamic Rep.	0.012	0.131	0.033	0.233	0.111*	0.014*	0.139	0.233
Iraq	0.114	0.057*	0.055	0.245	0.133	0.076	0.187	0.244
Jordan	0.127	0.166	0.145***	0.165**	0.178**	0.151**	0.071	0.174
Lebanon	0.021	0.193	0.165***	0.247**	0.199*	0.167**	0.196	0.265
Libya	0.140	0.087*	0.127	0.199	0.193	0.177	0.15**9	0.352
Malta	0.177	0.137	0.129*	0.197**	0.274*	0.323*	0.079	0.234
Morocco	0.097**	0.095**	0.135*	0.269*	0.085**	0.119*	0.169	0.375
Syrian Arab Rep.	0.098	0.161	0.145	0.189	0.112	0.119	0.187	0.234
Tunisia	0.188	0.024	0.165**	0.135*	0.236*	0.137	0.139	0.267
Yemen Rep.	0.088	0.036	0.095	0.199**	0.078	0.097	0.061	0.295
West Bank and Gaza.	0.099	0.011*	0.038	0.254	0.125	0.088	0.011	0.147
Notes: asterisks *, * and *** successively meaning the rejection of H0 at the 10%, 5% and 1% significance levels.								

By reading the above tables it can be noted that there are significant causality tests from finance to economic growth in high and low frequencies in the case of the GCC countries except Oman. This result is not surprising, if we know that Oman is the poorest country in the GCC and has been classified a high-risk countries according to the 1st quarter 2016 report of the credit insurer Euler Hermes.

In the case of Saudi Arabia, the results indicate that there is long-term (or low frequency) bidirectional causality at a significance level of 5%. We find the same result for Morocco but in the short term (2 years, 4 years). this can be explained by the fact that Morocco is the only country in the region that is relatively stable and has benefited from the disturbed situation in other MENA countries notably Tunisia. Indeed, flows of foreign capital and Morocco's exports were increased in an exceptional manner after the Arab Spring.

For non-member countries of the GCC, the causal relationship between financial deepening and growth vary across periods. In the case of Tunisia, Malta, Lebanon and Jordan, we note that, finance dominates economic growth in the long term or at lower frequencies (more than 4 years or $\alpha = \dfrac{\pi}{2}$) with a statistically significant level lower than 10%. In the short term this relationship is reversed but it becomes more important. The same trends emerge, in the short term in the case of Egypt, Algeria and Iran. For the remaining countries results are diversified.

3. Results analysis

The results highlight that, the intensity and direction of relationship between finance and growth vary according to the frequency. Sometimes this relationship is not present; and if there is a relationship the direction of causality can be unidirectional (from finance to growth, or from growth to finance) or bidirectional.

These findings challenge the conventional results according to which the relationship between finance and growth is linear. Thus, the reality is that this relationship may be influenced by many factors, and can take any shape.

The causal relationship ranging from finance to economic performance for some of the GCC countries can be explained on one side by the fact that these countries have a sizeable financial potential, on the flip

side by the greatest performance credits bank in this area. These effective credits are intended to finance companies that operate in sectors with high added value such as the oil sector.

In the rest of the MENA countries, the direction of causality is reversed for most of them, it becomes from economic growth to finance. This can be explained on one hand by political instability, which would result in the reduction of the entry of financial flows and the increase in capital flight. Indeed, in the Euler Hermes report- first quarter 2016, Only Morocco and the GCC have been rated low-risk countries. On the other hand by the relatively high level of inflation, this will increase nominal interest rates and decrease real returns on financial assets. In that case, as pointed Wachtel and Rousseau (2000), investors will be forced to acquire very liquid assets and thus invest less in projects that potentially generate a kind gross capital formation and growth.

V.   Conclusion

The main of this study is to show the limitations of traditional methods that have sometimes showed a total lack of links between financial variables and economic variables. For this purpose, a spectral analysis of causality between financial deepening and economic growth in MENA countries with different time horizons has been performed, the results highlight that this causal relationship is not linear but depends on the frequencies considered.

To get homogeneous data sources, the sample was divided into two subsamples, the countries of the Gulf Cooperation Council (GCC), which have a high income, and other countries.

The results indicate that causal relationships differ across countries. Indeed, the results show that financial deepening as measured by credit to the private sector; long term Granger causes economic performance in the GCC region, while for the rest of the MENA countries, economic performance precedes financial development. In the short term outcomes are not the same. They are reversed or indicate the presence of a bilateral causality.

Against King-Levine (1993 b) and Calderon -Liu (2003), for which finance dominates growth in developing countries; the present study has shown that there is not a single structure linking these two variables, which is valid for all countries and all times. The main conclusion that one can reach is that

each country has its economic and financial reality and must know how to conjugate them to ensure sustainable development.

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